

Mobile-based Primate Image Recognition using CNN

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Abstrak

Enam dari 25 spesies primata yang paling terancam punah berada di Indonesia. Primata ini yaitu Orangutan, Lutung, Bekantan, Tarsius tumpara, Kukang, dan Simakobu. Tiga dari enam primata tersebut kebanyakan hidup di pulau Kalimantan. Salah satu bentuk pelestarian khazanah primata yang terdapat di Kalimantan adalah dengan melakukan studi identifikasi primata. Pada penelitian ini dikembangkan aplikasi android dengan metode CNN untuk mengidentifikasi citra primata di lahan basah Kalimantan. CNN digunakan untuk mengekstrak fitur spasial dari citra primata sehingga sangat efisien untuk masalah identifikasi citra. Dataset yang digunakan dalam penelitian ini adalah ImageNets, sedangkan model yang digunakan adalah MobileNets. Aplikasi diuji menggunakan dua skenario yaitu menggunakan foto dan rekaman video. Foto diambil secara langsung, kemudian diperkecil menjadi resolusi 256 x 256. Untuk video, video diambil dalam waktu kurang lebih 10 hingga 30 detik dengan resolusi kamera 2 megapiksel. Hasil pengujian didapatkan rata-rata akurasi 93,6% saat menggunakan foto dan 79% saat menggunakan rekaman video. Setelah dilakukan perhitungan akurasinya, selanjutnya dilakukan uji usability dengan menggunakan SUS. Berdasarkan hasil SUS diketahui bahwa aplikasi yang dikembangkan layak untuk digunakan.

Kata kunci— Pengenalan Gambar, Aplikasi Seluler, CNN

Abstract

Six out of 25 species of primates most endangered are in Indonesia. Six of these primates are namely Orangutan, Lutung, Bekantan, Tarsius tumpara, Kukang, and Simakobu. Three of the six primates live mostly on the island of Borneo. One form of preservation of primate treasures found in Kalimantan is by conducting studies on primate identification. In this study, an android app was developed using the CNN method to identify primate species in Kalimantan wetlands. CNN is used to extract spatial features from primate images to be very efficient for image identification problems. The data set used in this study is ImageNets, while the model used is MobileNets. The application was tested using two scenarios, namely using photos and video recordings. Photos were taken directly, then reduced to a resolution of 256 x 256. Then, videos were taken in approximately 10 to 30 seconds with two megapixel camera resolution. The results obtained was an average accuracy of 93.6% when using photos and 79% when using video recordings. After calculating the accuracy, the usability test using SUS was performed. Based on the SUS results, it is known that the application developed is feasible to use.

Keywords— Image Recognition, Mobile-based, CNN

1. INTRODUCTION

Primates play an important role in research to improve human health. Despite being a small part of animals that are used in the biomedical field, primates share genetic and physiological similarities with humans, making them invaluable in developing treatments and vaccines for human diseases [1]–[3]. Primates also have important ecological functions in the ecosystems they inhabit, such as providing pollination services [4] and recognized as having an important role as a disperser of plant seeds [5]–[7] particularly in tropical rainforests [8].

Bristol Conservation and Science Foundation (BCSF), International Primatological Society (IPS), International Union for Conservation of Nature Species Survival Commission Primate Specialist Group (IUCN / SSC PSG), and Conservation International (CI) have published as many as 25 of the world's most endangered primate species [9]. Primates are threatened with extinction because of their natural ecosystems, mostly for commercial purposes, such as agriculture, livestock, commercial logging, timber harvesting, and fuelwood production [10]. Other factors are hunting, disease, climate change, loss, degradation and fragmentation of their habitats [11].

Of the 25 species found, six of which are found in Indonesia, namely Orangutan [12], [13], Lutung [14], Tarsius tumpara, Kukang Jawa, Simakobu [15], and Bekantan [11], [16]. The six primate species are scattered in three regions, such as Kalimantan, Sumatra and Bali. Of the six species, three of them mostly live on the island of Borneo, such as the Orangutan, Lutung dan Bekantan [16].

One form of preservation of primate treasures found in Kalimantan is by conducting studies on primate classification. With the primate classification, it is hoped that the public will be more familiar with protected primate animals. In artificial intelligence, especially machine learning, classification can be done by classifying primate images using a mathematical approach. Many methods can be used to classify images, including the Convolutional Neural Network (CNN). The CNN method can be used to solve problems related to image classification [17]–[20], recognition [21]–[24], and object detection [25], [26]. CNN is considered to have excellent accuracy and quality [17], [20], [27]–[29]. CNN uses a multi-layer neural network consisting of one or more convolutional blocks and sub-sampling layers, after which there are one or more fully connected layers and an output layer [30]. CNN's design is inspired by the structure of the mammalian visual system [31]. The most advantageous aspect of CNN is reducing the number of parameters in ANN [32]. Freytag conducted a study to identify chimpanzees using Log-Euclidean CNN with an accuracy of 92% [33]. Deb performed facial recognition of endangered primates, such as golden monkeys, lemurs, and chimpanzees, using the CNN method [34] with an accuracy of 88%. CNN is also used in the classification of medical images [35].

Based on the previous explanation, the researchers offer a solution for classifying primate images using the CNN method on an Android-based application. There are three types of primate images classified, namely Orangutan, and Bekantan. The application will be tested using two scenarios to calculate its accuracy. Also, usability testing was carried out using the System Usability Scale (SUS) to determine how easy it was for users to use the interface of the application being developed.

2. METHODS

The method used in this study consists of two stages, namely application development and application testing, as shown in Figure 1.

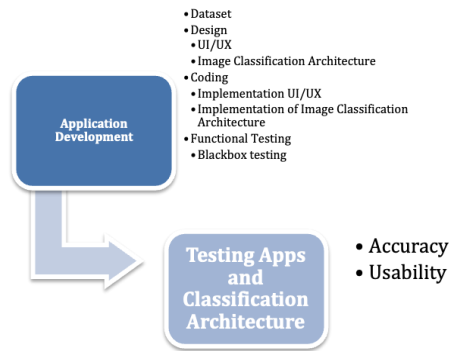


Figure 1. Research Method of Primate Wetland Image Recognition.

2.1 Application Development

Three steps were carried out at the development stage, namely interface design, code generation, and application functional testing.

2. 1.1 Dataset

The dataset used in this development is ImageNet. There are two species of animals to be classified, namely Orangutan (*Pongo pygmaeus*) and Bekantan (*Nasalis larvatus*). Samples of images from each class can be seen in Figure 2.



a. Orangutan (*Pongo pygmaeus*)

b. Bekantan (*Nasalis larvatus*)

Figure 2. Dataset of Primates

2. 1.2 Design

At this stage, the interface design and the architecture design of primate image classification were carried out. The application interface consists of three pages, namely a splash screen, an object detection page, and a page to display the detection results or descriptions of the objects that have been identified. Image classification architecture design can be seen in Figure 3.

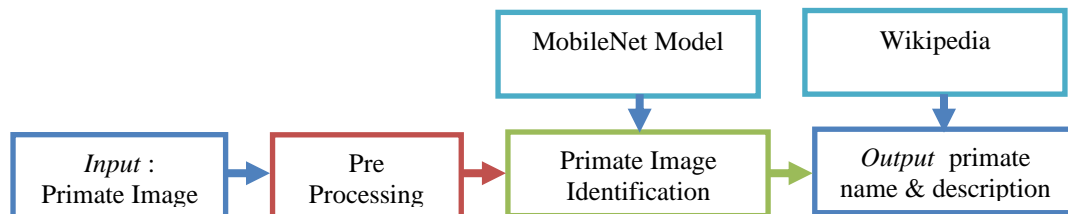


Figure 3. Primates Image Classification Architecture Design

Based on Figure 3, the first step in the primate identification process was to receive input in the form of photos or videos of primates directly. Photos are taken directly, then reduced to a resolution of 256 x 256. For videos, videos are taken for approximately 10 to 30 seconds with a 2-megapixel camera resolution. The second step was pre-processing to speed up the identification process. The kind of pre-processing that was done is to reduce the size of the photo to 256 x 256 pixels.

In the third step, the imaged primate images were compared using the MobileNets model to determine the primate's name. MobileNets is one of the Convolutional Neural Network (CNN) architectures that can be used to overcome the need for excessive computing resources. Once the name of the primate is known, the application will search for descriptions on the Wikipedia site based on the primate name. The final step, the output of the application was to display the name and description of the primate.

2. 1.3 Coding

At this stage, code was generated for the application of interface design and image classification architecture in Android-based applications. The coding was made using android studio, firebase, and tensorflow [28]. The application was designed to run well on android 4.1 and up.

2. 1.4 Functional testing

The functional testing was carried out using BlackBox testing by testing all functional features in the application, such as photo and video detection functions and the function of displaying results. It also ensures that there are no errors during the identification process of primate animals, resulting in the application not running properly or errors.

2. 2 Application testing

There were two types of testing at the application testing stage: testing the accuracy and testing the application's usability using the System Usability Scale (SUS) [36]. Application accuracy testing was carried out to obtain the accuracy of primate recognition from the application being developed. Testing was carried out using two scenarios as follows:

First Scenario: Photos of 3 types of animals were downloaded; each type consisted of 30 photos. The photos were recognized using an application that had been developed, then the results of the recognition were recorded to calculate accuracy.

Second Scenario: The application was tested by classifying using video, the application was highlighted to the primate video, then the recognition results were recorded to calculate accuracy.

After calculating the accuracy of the application, the next step was to test usability using SUS, which consists of 10 questions with a ring scale answer, from 1 to 5. Figure 1 shows that the user strongly disagrees with the test statement, and number 5 states that he strongly agrees with the test statement [37]. Usability testing is used to see how easy the user uses the application interface.

3. RESULTS AND DISCUSSION

This current study used 300 primate images for testing the first scenario and 30 videos for testing the second scenario. The purpose of this experiment is to measure the accuracy of the architecture that we design. After that, we also use SUS to measure how easy it is to use the interface of the developed application.

3. 1 Application Development Results

Figure 3 shows the results of developing an android application using the CNN method. The user will first enter the primate identification interface to identify the desired object, as shown in Figure 4a.

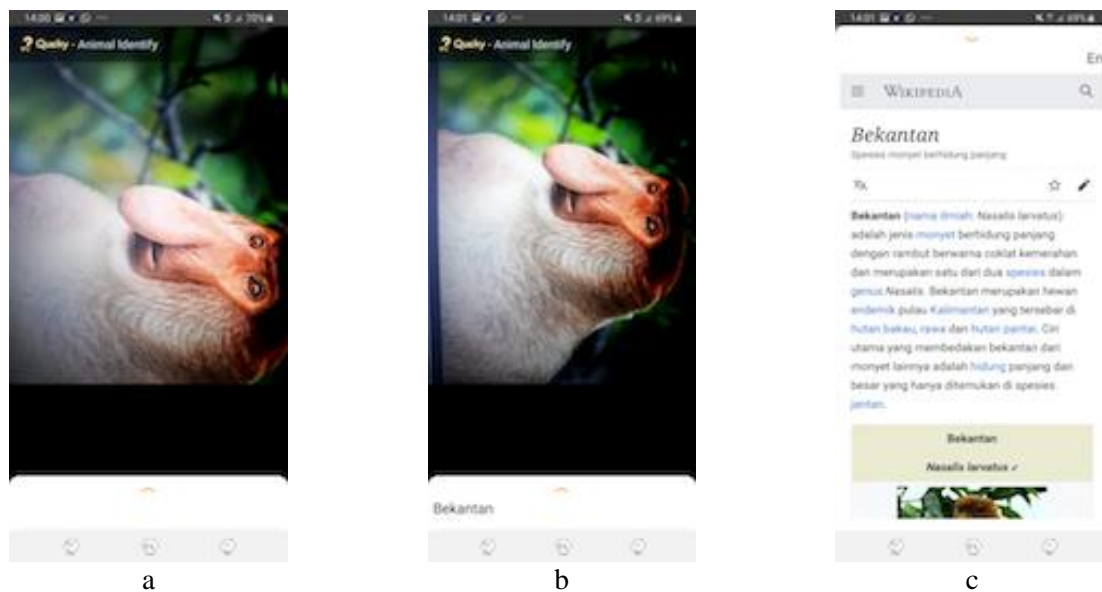


Figure 4. The interface of Primate Animal Identification App: a). display when reading recognized primates. b) display when displaying detection results. c) display when displaying a description of the recognized primates

3. 2 Accuracy and Usability Testing Results

Testing was carried out using 30 photos from each of the three categories tested with two scenarios by five application users. The first scenario is done by using photos, and the second is using direct object detection. The test results can be seen in Table 1.

Table 1. Accuracy results from 2 scenarios

User to	Primates Species	Accuracy (%)	
		Scenario 1	Scenario 2
1	Bekantan	87	100
	Orangutan	83	100
	Average	85	100
2	Bekantan	93	40
	Orangutan	97	37
	Average	95	38.5
3	Bekantan	100	100
	Orangutan	100	100
	Average	100	100
4	Bekantan	97	100
	Orangutan	93	100
	Average	95	100
5	Bekantan	93	33
	Orangutan	93	80
	Average	93	56.5
Grand Total		93.6	79

SUS is a measuring tool that assesses usability of a product. There are some characteristics of SUS that make it attractive and different from other questionnaires. Although it cannot help in determining the factors or features that are still problematic in the system, the system usability scale can help in determining whether the system can be used properly.

Table 2. SUS Testing Results

Respondents	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total	JML * 2.5
1	2	4	4	3	2	4	4	4	3	3	33	83
2	3	2	4	4	3	3	4	3	4	4	34	85
3	2	1	4	3	2	1	3	2	4	4	26	65
4	0	4	4	4	0	0	0	4	4	0	20	50
5	3	1	4	3	2	2	3	3	2	3	26	65
6	2	2	3	4	2	2	3	3	3	3	27	68
7	3	3	4	3	3	1	3	3	3	3	29	73
8	2	3	3	3	3	2	3	2	3	2	26	65
9	3	3	4	3	3	1	4	3	3	3	30	75
10	3	2	3	1	2	2	4	3	2	3	25	63
11	3	2	1	2	1	1	4	3	1	4	22	55
12	2	3	4	2	3	2	4	3	2	3	28	70
13	3	4	4	3	4	2	4	3	3	3	33	83
14	4	4	4	3	4	3	4	3	4	2	35	88
15	2	4	1	4	2	1	4	2	3	4	27	68
16	0	3	4	3	0	4	2	4	0	4	24	60
17	4	3	3	4	4	2	4	4	4	4	36	90
18	2	3	3	3	2	3	3	3	0	4	26	65
19	2	1	2	4	2	3	4	3	0	0	21	53
20	4	4	4	3	4	2	4	3	1	4	33	83
21	2	3	4	4	1	1	3	4	2	3	27	68
22	4	2	4	1	3	3	3	4	4	1	29	73
SUS results											70	

The letter Q in the table stands for Question to n. Based on the results of the SUS calculations presented in Table 2, the usability value from respondent 1 to respondent 22 is 70. This indicates that the application is suitable for use.

4. CONCLUSIONS

Primate image classification is a difficult task to undertake because there are so many variations. In this paper, we try to use MobileNet to classify primate images. The experimental results show that MobileNet works very well, similar to the results obtained by previous researchers who also used MobileNet. The average accuracy in this study was 93.6% when using photos and 79% when using video recordings. Based on the usability test using SUS, 70 was obtained, which means that the application is feasible to use.

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